

temperature of the inshore water much below the normal, a coast climate, peculiar in many respects, is produced, the remarkably low summer temperature being the most striking peculiarity.

7. Thus the "Egyptian winters and Alaskan summers" (24) experienced in San Diego are explained as a necessary consequence of the operation of physical laws in connection with the distribution of land and water areas, hence the stability of the climate of San Diego is comparable with the stability of the present geological features and astronomical configuration.

In conclusion, I wish to thank Dr. W. E. Ritter and Mr. E. L. Michael for their suggestions relative to the presentation of the subject in a form comprehensible to the general reader, and Mr. C. J. Marvin, of the Scripps Institution, for his assistance in making the drawings.

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- (25) The pressure gradient or barometric gradient is the rate at which the pressure decreases in going a unit distance horizontally along a level

surface from a place of high to one of low atmospheric pressure, or vice versa.

(26) Under these conditions, a plumb line would coincide with the earth's radius produced through the point of suspension.

(27) The trade-wind theory advanced by George Hadley (9) required a steady increase in pressure from the equator to each pole, according to the observed decrease in temperature. But barometric observations taken from 1839 to 1843 (4) contradicted this theory, and the general problem of pressure distribution and atmospheric circulation remained inexplicable until Ferrel developed his theory of atmospheric circulation during the period from 1856 to 1882.

(28) Atmospheric pressure is expressed in inches of mercury throughout this paper.

(29) The centigrade scale of temperature is used throughout this paper.

(30) The general relation is D (in meters) = $\frac{3.4}{\sqrt{\sin L}} W$, where L is the latitude and W is the wind velocity in miles per hour.

(31) Wind-current is a technical term used to denote the current in the upper part of the water, produced by a wind under the conditions assumed on p. 20.

(32) The wind blows from the direction named.

LORIN BLODGET'S "CLIMATOLOGY OF THE UNITED STATES": AN APPRECIATION.

By ROBERT DE C. WARD.

[Dated, Harvard University, Cambridge, Mass., Sept. 22, 1913.]

So impossible is it to keep our heads above the rising tide of the new meteorological literature that we are neglecting, to our loss, the rich stores which lie buried in the books of a generation ago. The name of Lorin Blodget is probably known to Americans chiefly through their reading of the sections on the United States in Dr. Hann's *Handbuch der Klimatologie*, where the ranking meteorologist of to-day makes appreciative reference to, and quotation from, the work of our pioneer American climatologist. Yet Blodget's discussion was of fundamental importance, and is, even now, worthy of the attention of all our students of climatology.

During the short semi-vacation of the past summer, spent among the New Hampshire hills, I have turned again to Blodget's *Climatology of the United States* for relaxation and for instruction. More than ever before, I am impressed by the labor involved in the preparation of this book; by the author's broad and clear view of his subject; and by the practical application of the facts. My rereading of this book has given me new light on my path as a teacher. And I hope that this notice may turn attention once more to the importance of Blodget's work for American climatology, and may help to preserve for this almost forgotten author of 50 years ago the place to which he is entitled among American meteorologists.

It was no easy task which Lorin Blodget set for himself.¹ It would have discouraged many men. But Lorin Blodget did it. And he did it well. No one else has attempted, much less carried through, so ambitious an investigation. Gratefully, and gracefully, does our author acknowledge his indebtedness to Alexander von Humboldt, whose "models were his guide" and whose "tone of generalization" it was Blodget's "highest ambition to attain." Out of the confused mass of scattering observations which had been accumulating from different sources at the Smithsonian Institution and the Office of the Surgeon General, and from "gentlemen at distant points distributed over the country," Blodget brought

¹ The full title of the book is as follows: "Climatology of the United States, and of the Temperate Latitudes of the North American Continent: Embracing a full comparison of these with the Climatology of the Temperate Latitudes of Europe and Asia, and especially in regard to Agriculture, Sanitary Investigations, and Engineering, with Isothermal and Rain-Charts for each Season, the extreme Months, and the Year. Including a Summary of the Statistics of Meteorological Observations in the United States, condensed from recent scientific and official Publications." (Philadelphia, J. B. Lippincott & Co.; Trübner & Co., London, 1857. xvi, [17]-536 p. 4*.)

order and accuracy so far as was then possible. Clearly recognizing the necessary inaccuracies in his results, although "great care had been taken to correct and verify the records," Blodget realized that they "would still have great practical value in engineering, agriculture, and sanitary investigation." It might perhaps be well, to-day, if less time and money were sometimes spent in the effort to insure the highest possible accuracy of our records before we begin to make *practical* use of them. We may well believe that the work of our author "was prosecuted with excessive labor," and that "no part of the present work * * * is the result of hasty or superficial discussion." The practical features of American climatology were foremost in his mind throughout, "in part for the reason," as he clearly saw, "that a research in this new department of physics must commend itself to economical interests or fail to be sustained." With these practical objects in mind, Blodget planned his book along lines which must command themselves to the preeminently practical spirit of our own times. A teacher of the climatology of the United States might do much worse than follow, as an outline, the chapter headings of Blodget's volume.

The keynotes of the book are struck in the *Preliminary Chapter*—the advantages of the longer series of European records; the importance of a knowledge of the climates of the interior and of the West "from the point of view of climatological adaptation to occupation by populous States;" the "symmetry of arrangement" in the climates of Europe and of North America. It is surely practical climatology at its best when we learn that "the cultivation and productive capacity of England may be reproduced on the Pacific here, and all the vast systems of industrial, commercial, and social results which follow in the train of such conditions." Of the magnitude of his undertaking Blodget was painfully conscious. Each division of his subject, he wrote, "requires a volume rather than a chapter," and "for all taken together" it is "such as it is scarcely possible for one person to make." In the early fifties a total of 583 stations in the United States—of 639 in temperate latitudes as a whole—gave a considerable foundation upon which to build. This was the material upon which Blodget based his conclusions, and which he laboriously collected and summarized. His *Summary* includes several of our historical long period records, such as that for Charleston, S. C., from 1738; Boston and vicinity from 1780; and New Bedford, Mass., from 1812. The broad and essential topographic features which control our climate are described under the suggestive chapter heading, *Climatological Features of Surface and Configuration*. Special emphasis is laid upon the uniformity of surface and of climate over the eastern United States, where, in spite of the mountain masses of Appalachians, Adirondacks, and White Mountains, "the forests and general climate remain as before."²

Those—and there are many—who believe that local topography produces local climates *essentially different* from the general conditions of the surrounding country may well remember Blodget's statement just quoted: The general climate remains. "We scarcely regard the Alleghenies," he says, "as disturbers of any condition of climate except in the moderate degree produced by altitude alone, as they are ascended." In the Rocky Mountains "climates with great extremes of temperature necessarily follow" from the plateau character of the topography, and the Pacific coast mountains, though they occupy but a narrow space, "shut off the basins of the interior as

effectively as if a great distance and many ranges intervened." The expression *climatological topography* (p. 101) seems to me particularly significant and worthy of extended use. A sharp insight into the relative conditions in Eurasia and in North America is indicated in the contrast between the presence of "deserts and Asiatic features at the first eastern foot" of our Pacific coast mountains, while similar climates do not appear in Eurasia for "50 degrees of longitude of a climate ranging from oceanic or maritime." Blodget's clear reasoning regarding the existence of prevailing westerly winds over the temperate latitudes is well worth quoting:

In proof that such a belt exists the difference of temperature of the opposite coasts of both [North America and Eurasia] seems a conclusive evidence. If no atmospheric circulation modified this distribution by conveying the heated or refrigerated air in some direction, there is no reason for any such difference as we find to exist. The maximum of continental effect in refrigeration and aridity should be found in the center of the continent, and its degree should be as great on the west as on the east.

In a later chapter the trend of the isotherms and the difference in temperature and in humidity on the opposite sides of the continent are also taken as evidence of the prevailing westerly winds. While our Great Lakes do locally modify some of the extremes of continental climate, they are themselves the product of abundant rains, and "could not exist if extreme continental features of climate were ever fairly developed there." In other words, the Lakes modify the climate, but exist because the climate is modified!

This is a striking statement, and it is true. In a discussion of the *General Character of the Climate of the Eastern United States*³ we find many of the larger climatic characteristics set forth as clearly as they have ever been presented, before or since. The continentality of the Atlantic coast climate, with its slight marine modifications, is admirably described by stating that on the immediate coast "a local oceanic climate exists, *but it is always blended with the continental features* which belong to this part of the continent generally." In his general summary for the eastern United States Blodget says:

The principal feature of this area as a whole is its adaptation to a great range of vegetable and animal life. It is extreme without being destructive, and it brings in tropical summer temperatures and profusion of rain with low winter temperatures, near to those of the extreme continental climates; and the result is a condition extremely favorable to the acclimation of tropical or semitropical plants and animals. * * * It is simply an excess of temperature and of humidity, *engrafted on, without otherwise changing, the characteristic laws elsewhere belonging to much lower temperature.* * * * Cotton, Indian corn, and the cane find their natural climates here, but not elsewhere, in any considerable degree, beyond the Tropics.

Over all this eastern area, cyclonic weather changes—"oscillations of every sort," Blodget calls them—are "symmetrical and uniform." The expression *paroxysms of change*, used for the sudden shifts characteristic of the passage of cyclones, especially in winter, seems to me very fitting. The increase of temperature in front of an approaching cyclone, "of duration proportioned to the measure of the change that is to occur"; the explanation of the more emphatic development "of the last phase" of the cyclonic "circuit" by reference to the general atmospheric movements from the west, "with which this phase of the change coincides, and to which it is *superadded*"; the sympathetic allusion to the prevailing summer wind as "the soft, pleasant, peculiarly American wind, with a finely variable force"; the recognition of the "patchy" occurrence of frost when it is referred to "as though dropped from the atmosphere"—these are but a few

² The italics here and in later quotations are mine.—R. DEC. W.

³ Chapter III.

of the interesting points contained in this chapter. At the end are some notes on occurrences of severe cold, as valuable to-day as when they were compiled. On the severe winter of 1780 we read that Washington sent troops across "an unbroken body of solid ice" to attack the British on Staten Island, and on February 6, 1786, sleighs were sent over the ice with provisions for the troops.

A good working knowledge, if it may be so called, of the climatic characteristics of the interior may be gained from Blodget's summary.⁴ The "absence of atmospheric moisture" is noted; "sensible perspiration is rarely experienced in even the warm climate of southern New Mexico," and "the languor and oppressiveness attending a heat of 90° to 95° in the eastern States is never felt at such temperatures"; and the dry winter cold of the interior is more easily borne than damp cold. Practical results of the low relative humidity are seen in the fact that "the valuable grasses" dry "without loss of their nutritive qualities," and the "absence of humidity" is also "very favorable to observation of astronomical and other instruments." Periodic, diurnal controls are dominant, while changes "of what may be called the greater nonperiodic sort" distinguish the east. "Extreme contrasts, diversities, and transitions belong here [in the interior] to *place*, or *locality*, and in the east to *time*." This is a significant summary.

A live *Comparison of the Arid and Interior Areas of North America and of Eurasia*, based on selected descriptions, illustrates very well how vivid a picture of climate can be drawn without endless tables of numerical data and without even a single curve.⁵ Similarities in modes of life are emphasized and predictions regarding the future climatological capacity of North America are made. "There is no climatological reason," says the author, "why the Rio Grande, Gila, and Colorado Rivers should not be lined with spots of rich, half-tropical cultivation, like the Tigris and Upper Indus." Blodget lived to see at least some of his prophecies fulfilled.

Even the most enthusiastic resident on our Pacific slope will be satisfied with Blodget's reference to "the elastic atmosphere and bracing effect" which "constitutes a striking difference from those of the Eastern States."⁶ There is no climate on the slope "which is not the reverse of enervating." * * * All residents concur in pronouncing it more favorable to physical and mental activity than any they have known, from whatever quarter they come." I know of no briefer yet more comprehensive and suggestive climatic comparison than this, that "the Pacific coast climates are Norwegian, English, and Spanish or Portuguese, with the intermediate France blotted out." The general character of the storms, of the on-shore winds and of the fogs at San Francisco, is described in well-chosen quotations from Dr. Gibbons (pp. 196-198), who gave us, years ago, graphic accounts of Pacific coast weather phenomena which have lost nothing by the passage of time. The easterly storms of the Atlantic climates, Dr. Gibbons says, are unknown there. "In almost every month of the year, even during the dry season, the clouds *put on the appearance of rain* and then vanish. It is evident that the phenomena which produce rains in other climates are present in this, but not in sufficient degree to accomplish the result, except during the rainy season, and then only by paroxysms with intervening periods of drought." Where can we find any more

graphic account of San Francisco's summer than in Dr. Gibbons's description which ends: "In short, there is no conceivable admixture of wind, dust, cloud, fog, and sunshine that is not constantly on hand." "It is unfortunate," Blodget continues, "for the productive capacity of that side of the continent that the mountains are so near the coast, and that the climate changes so soon in consequence"—a sentiment with which most of us cordially agree.

In a further comparison of Europe and North America,⁷ when Blodget says of Vancouver Island that "the whole climate, indeed, is peculiarly soft, equable, and *English*," he gives one an admirably condensed and accurate statement. The charts (isothermal and isohyetal) are obviously long out of date, but the critical comparisons made by our author are worth attention. He emphasizes an important *practical* climatic fact when he says that "the local influence of the icy region of Hudson Bay reduces the cultivable capacity by cooling the summer." And his comparison of western European and eastern North American climates is worth quotation.

From Europe as a standard, the American climate is singularly extreme. * * * The oscillation of the conditions is greater, and they vibrate through long measures above and below the averages. All the irregular as well as regular changes are of this sort, and the European observer defines the climate as directly antagonistic to that he has left.

As a general description of seasonal weather types in the eastern United States, where have we anything more sympathetic, or more vivid, than the following?

In summer the whole area of the United States is * * * occupied by this predominating feature—the irregular distribution of profuse showers alternating with entire serenity. Nowhere else are thunder-showers such grand and conspicuous phenomena, occurring at intervals on successive days, and with a stately and almost orderly distribution over great belts of country. In the Northern States they are more constant than in the Southern, or more likely to occur on the afternoon of every day through the warmest month or months, while at the thirty-fifth to the forty-second parallel they usually occur in belts, continuing even two or three days, and embracing a district equal to that from St. Louis to Philadelphia; this belt or period to be succeeded by one entirely serene, of equal extent and duration. * * * There is no feature of climate more attractive than this constant succession of the showers of summer in the middle and northern latitudes of the United States. * * * Periods of excessive heat and saturation, of two to five or eight days' duration, are common in the American summer, and quite characteristic of it. * * * These warm periods continue over several days also, and if the air is dry the temperature readily rises to about 100°. If saturated, or nearly so, it rarely goes above 95°, but the effects are very destructive in these cases, great mortality occurring in the cities from "sunstroke."

Our author says:

As the summer advances, the intervals of dry weather usually increase in duration, and in the early part of autumn these several periods are sometimes of 15 days' duration. * * * West of the Lakes, or of Lake Erie, the rain in autumn rapidly diminishes, and the long, dry, smoky intervals occur in their most complete development. * * * Where the autumn does not differ largely from the quantity of rain at other seasons, as in New England and farther northward, there are still intervals of the serene and beautiful weather so prevalent on the plains. The popular designation of *Indian summer* is universal, and it is held certain that one such period, of some days' duration, will occur in October of every year. * * * It is here clearly nothing more or less than smoke and vapors suspended in an atmosphere of unusual quiet. * * * The prevalent winds in the United States are from the west, and after the heats of summer immense areas of dry grass of the plains are constantly burning. This smoke is wafted eastward, and in the light atmosphere it descends, filling the surface air sometimes so much as to give it a stifling closeness.

Then quoting from Drake's description of Indian summer in the region about Cincinnati, Blodget proceeds:

The atmosphere during its continuance is tranquil, temperate in heat, and hazy; but not much obscured by clouds. *Falls of rain are,*

⁴ Chapter IV.

⁵ Chapter V.

⁶ Chapter VI. *Distinctive features of the Pacific Coast Climates.*

⁷ Chapter VII. *General Comparison of the Temperate Climate and of the Eastern United States with the West of Europe.*

however, not uncommon; and in general the whole appearance breaks up with a rainstorm, followed by a winter temperature. An apparent smokiness through which the sun and moon, when near the horizon, and especially at evening, appear of a crimson hue, is the great characteristic of the season.

The chilling northeast winds [of the eastern United States, Blodget points out] are distinguishingly American. * * * On the New England coast the sea influence is always great, and local mists with chilling sea winds prevail very much at certain seasons. The northeast wind is the natural storm wind of all this coast, attending all the general storms as a persistent phenomenon of two or three days' duration. * * * It is felt on the plains beyond the Mississippi, at the head of Lake Superior, and in Texas not less decidedly, though less frequently and of less duration, than on the coast of New England. But in the last locality it bears the ocean scud and mist with it, and produces an extremely chilling effect at all seasons.

Concerning winter weather types we may quote the following:

The piercing and violent northwest winds which follow a storm or a period of warm weather appear colder, or are felt to the senses as colder, than the thermometer would indicate; and the intense cold of winter in the interior is not so uncomfortable as it is in Boston, although the thermometer may fall many degrees lower. The Atlantic coast is one of almost constant atmospheric disturbance, or the conditions vibrate in one direction to return immediately through the same range. There are none of the "dead calms" which exist in the interior of continents in winter as well as in summer. * * * It is the most decisive proof, perhaps, of the extreme character of the American climate in comparison with the European, that the snows of winter are thrown so far south and into latitudes where the summer heats are tropical.

The expression *thrown*, for the cyclonic effects in carrying snow far south seems a particularly happy one.

The smaller area of the subtropical belt in North America than in Europe often puzzles younger students. On this point our author clearly says⁸:

If the Gulf of Mexico were similar in position to the Gulf of California, yet extended inland like the Mediterranean, the districts of the various local peculiarities now bordering on the Mediterranean would be reproduced. * * * The space where we may look for phenomena correspondent to those of the Mediterranean is here relatively very small.

The unfavorable effect upon crops of the "nonperiodic extremes of cold occurring at distant intervals" along the borders of the Gulf of Mexico is emphasized. This is one of the marked, and, economically, one of the most unfortunate, climatic characteristics of the eastern United States.

Much of Lorin Blodget's best pioneer work was done in the construction and discussion of his seasonal and annual temperature and rainfall charts, in which he took pardonable pride.⁹ The details are naturally out of date, but there is reference to many *general* facts of importance to-day. For example, we are reminded of the parallelism of summer isotherms and the Pacific coast, giving "almost absolutely equal temperature" along this coast, while off the Atlantic coast the lines "double on themselves abruptly;" the remarkable uniformity of summer temperature over the interior; the occurrence of the winter minima to the west of the Great Lakes, "the point of natural minimum" being "broken up" by the lakes, whose location is "most fortunate for the cultivable districts of this part of the United States;" the diminished warming effect of the Gulf of Mexico waters in winter owing to the "great relative refrigeration of the continent, generally and the consequent prevalence of land winds" (i. e. offshore), and the similar condition along most of the Atlantic coast, where, "if the prevalent winds were reversed, the climate would be *greatly softened*." Blodget lays none too much emphasis upon the remarkably favorable conditions of summer rainfall over the Missis-

issippi Valley. "There is no great area so far in the interior," he says, "which presents a similar result."

In the discussion of the winds¹⁰ the relation between temporary cyclonic and permanent westerly winds is clearly recognized, and the Texas monsoons are called by that name,¹¹ their cause is indicated and their climatic consequences are appreciated. The section on winter storms¹² brings out some of the results of Blodget's laborious study of these phenomena. He constructed, in all, some 50 or more "elaborate charts * * *," so as to give successive panoramic views, as they may be termed, of the whole country at a definite hour.¹³ Variations of temperature and pressure from the mean; winds; and cloud and rain areas, were shown on these charts. Several expressions are worth remembering. The change to a rainy spell is usually inaugurated by "a south or southeasterly wind, with high temperature and a *palpable sense of preparation*." This *palpable sense of preparation* we have all of us noted time and again, but no one else has described it in such a vivid way. The expression that as our storms advance the northeast winds in front "*recede eastward*" is also a striking one. That cyclones move along isotherms is also seen. In regard to the origin of our cyclones, "they originate in changes of the measures of heat and moisture introduced from exterior sources, and * * * these changes are absolutely non-periodic and can not be foretold." A good many meteorologists of the present day might find this a fair statement of their own views.

Three chapters (XIII-XV) deal with the "climatological range" of forests and of certain crops and grasses. This eminently practical matter is often omitted from climatological discussions, which therefore lack the vivid and essentially human quality. But Blodget was keenly alive to all the practical aspects of his subject. The "primarily climatological" control of our forests and the need of "accurate climatological distinctions" in dealing with the distribution of our native and cultivated plants is vividly brought to the reader's attention. The term *climatological capacity*, which Blodget uses, seems a singularly happy one. It expresses, briefly, what we generally try to define by means of a lengthy circumlocution. A point of practical importance concerns the use and making of hay:

As a whole, the American climate is singularly favorable to the making and preservation of hay or dried grasses—the natural hay of the plains being unparalleled indeed. The long winter in the Eastern States requires a much larger preparation of hay than the English climate, and the summer is much more favorable than that of Europe for this preparation.

The historical background of Blodget's times is clearly seen in the discussion of the relations of climate and health.¹⁴ Military posts in "newly acquired territories" in the South and West were then kept "at the exterior limits of settlements in all cases, as the control of the Indian tribes required." Thus were the early records begun by the Medical Corps of the Army. Thus were laid the foundations for the medical climatology of the United States. Such a statement as this, "that India itself has not been more certain to break the health of the emigrant than the Mississippi Valley," shows how crude and unreliable was the medical and climatic knowledge of those days a generation ago. The disappearance of malaria and of yellow fever with the cold, and the prevalence, in their place, of "the forms originating in the sharp temperature changes of the cold zone," are

⁸ Chapter VIII.

⁹ Chapters IX and X.

¹⁰ Chapter XI.

¹¹ "Something very near a monsoon."

¹² Chapter XII.

¹³ Chapter XVI.

accurately noted, as is the fact that great variations of temperature and humidity in a climate generally cool and damp afford the conditions most extremely favorable "for pulmonary tuberculosis." One other point, which deserves constant attention in all our statistical studies of medical climatology to-day, is this:

Large numbers seek milder climates and perish there, whose cases should be set down to the country from which they came.

A chapter (XVII) on the *Permanence of the Principal Conditions of Climate* is appropriately included. A summary of the literature, so far as it was known to him, is given by the author. "For the whole of the vast historic period," he says, "there have been the same deserts in Africa and Asia, the same absence of water in the rocks and soil." As to the evidence for and against climatic "change," our author rightly holds that "real history would be more valuable than anything else if it could be relied on, but there is great looseness with much exaggeration in everything dating back beyond the use of instruments." Blodget believes that "the Northmen found the New England coast 860 years ago quite precisely the same in climate as now—wild vines growing in a very few of the most favored spots, and only in these." In Iceland and Greenland he finds no evidence of a change of climate; only a change in the conditions of people and of government. Dr. Hugh Williamson is quoted as saying, in 1770, that the winters of the last half century had been milder than formerly, and Prof. Samuel Williams, of Harvard College, whose lectures were among the foundation stones of American meteorology, asserted that "the winter is less severe, cold weather does not come on so soon." These views sound singularly like many that we hear expressed in 1913. For Europe and Asia authorities are cited, and the need of accurate observations, extending over long periods, is clearly recognized. The dates of the breaking up of ice in Russian rivers are given back to 1530.

In a section on *Physical Constants*¹⁴ various temperature and pressure data and curves and some meteorological tables are given. Finally, at the end, in a discussion of the climate of the Northwest,¹⁵ Blodget stands out as preeminently a *practical* climatologist. How crisp, clear, confident, and encouraging is his assertion made, we must remember, before the days of our western railway network; before the great waves of population had rolled over the West; before systematic and well-directed observations were available for all this region—that "it is impossible to doubt the existence of favorable climates over vast areas now unoccupied."

It is thus that I wish to conclude this appreciation of Blodget's *Climatology of the United States*, hoping that what I have written may refresh the memories of those who already know the book, and may stimulate others to turn to the original for the inspiration which no reviewer can hope to give.

IS THERE AN AURORAL SOUND?

By JOHN OXAAL, Christiania.

[Translated by Julius C. Jensen from the reprint from "Naturen," April, 1913.]

The northern or polar lights have from the earliest of times, by reason of their prominence in the polar night, attracted the attention of man and compelled him to examine and study them. When it now chanced that science undertook their investigation there remained cer-

tain attendant phenomena which defied all explanation. I have in mind a phenomenon in regard to which there have always been sharply defined differences of opinion, which, after all, can perhaps be scientifically explained.

It is this: Are strong auroral displays accompanied by sound? What kind of a sound is this? Under what conditions does it occur? Reports of distinct crackling noises in connection with strong, flaming auroras are almost numberless, but, so far as is known, this sound has never been observed by those expeditions which have been sent out for the express purpose of studying the aurora, although there are many accounts in which other scientists purport to have heard it.

Sophus Tromholt made a long series of systematic observations of the aurora, and in old files of *Naturen* are found various discussions by him; but although his attention was directed especially to the question of the auroral sound, his investigations led to no affirmative results in regard to it. Haakonson-Hanson also made careful observations of a similar nature in Trondhjem, but heard no sound. However, it ought to be pointed out that a city is not a favorable location for observations of this kind.

Among the rank and file of the people a strong belief prevails that such a sound actually exists. How general this belief really is appears in an article in *Naturen* for the year 1892. In consequence of this belief Sophus Tromholt, in 1885, sent out questions concerning both the aurora and the auroral sound, to a large number of those interested in the subject in all parts of the country. Out of 143 who answered, no less than 56, or about 36 per cent, testified to having heard the sound themselves.

It is not merely scientists who, in the course of time, have applied themselves to this problem, and since in most cases the investigations have given a negative result, it is hardly to be wondered at that the numerous accounts which have come mostly from laymen should be regarded with skepticism. It must be remembered that the aurora belongs to that class of phenomena which tends in the highest degree to arouse the imagination. Is it not possible that one may be so influenced by the sight of a gloriously flaming, rapidly shifting aurora, playing in colors of sheerest blue, red, green, and violet, while rays of light suddenly shoot out and disappear again, as to imagine that one actually hears at the same time a crackling, rustling sound? Bearing this in mind, it is perhaps not unreasonable that one should have been led to question the word of scientists who, on other occasions, have shown themselves to be keen and sober observers, and thus have come to regard the whole phenomenon with doubt.

Under these circumstances I believe each individual observation may have a significance, and I will therefore set forth the following:

On a trip to the most northerly part of Finland, in the autumn of 1911, I remained for some time 2 or 3 miles¹ south of Lake Enare. On returning to my hut after the day's work on October 10, while my Finnish guides were preparing supper I witnessed the most beautiful auroral display I have ever seen. Several parallel bands, now two, now three, which alternately united and divided, streamed across the sky from the west through the zenith to the east. They were in constant wave motion, one instant slow and deliberate and the next swift and impetuous, while rays of light darted out from them and disappeared again.

¹⁴ Chapter XVIII.

¹⁵ Chapter XIX.

¹ Norwegian miles. One Norwegian mile equals 7 English miles.